higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

REPORT 191 PROGRAMME

SYLLABUS

ENGINEERING SCIENCE

N4

Implementation: May 2022

1. INTRODUCTION

1.1 General Aims

This subject builds onto the basic knowledge attained in Engineering Science N1, N2 and N3. This subject involves knowledge of various systems and components, hence when presenting modules for the subject, attention should be taken that the students understand each basic scientific principle in such a way that they will be able to integrate this knowledge in their applied subjects.

1.2 Specific Aims

On completion of all the modules in Engineering Science N4, the students should be able to apply the scientific principles mastered to his specific trade theory. Students should be able to apply SI units and derived units correctly. Students should be able to demonstrate understanding of subject content through the application of acquired knowledge. Students should also be able to solve problems by using subject content. Students should be able to acquire in-depth knowledge of the following content:

1.2.1 Kinematics
1.2.2 Angular Motion
1.2.3 Dynamics
1.2.4 Statics
1.2.5 Hydraulics
1.2.6 Stress, Strain and Young's modulus
1.2.7 Heat

2. Admission requirement (Pre-requisite)

Passed N3

3. Duration

The duration of the subject is one trimester on full time, part time or distance learning mode.

4. Evaluation

Candidates must be evaluated continually as follows:

4.1 ICASS Trimester Mark

4.1.1 **Two** formal class tests for full time and part time students (or **Two** assignments for distance learning students only)

4.1.2 Obtain a minimum of 40% in order to qualify to write the final examination.

4.1.3 Assessment marks are valid for a period of one year and are referred to as ICASS Trimester marks.

4.1.4 Calculation of trimester mark

Weight of test or assignment 1 = 30% of the syllabus

Weight of test or assignment 2 = 70% of the syllabus

4.2 Examination

4.2.1 The examination shall consist of 100 % of the syllabus

4.2.2 Duration shall be 3 hours

4.2.3 Minimum pass percentage shall be 40%

4.2.4 Closed book examination

4.2.5 Knowledge, understanding, application and evaluation are important aspects of the subject and should be weighted as follows:

Knowledge	Understanding	Application	Evaluation
60%	20%	15%	5%

4.3 Promotion Mark

The promotion mark consisting of the combination of the Trimester and Examination marks, shall be a minimum of 40%

WEIGHTED VALUES OF TOPICS

MODULES		WEIGHTED VALUE %
1	Kinematics	15
2	Angular motion	12
3	Dynamics	14
4	Statics	15
5	Hydraulics	15
6	Stress, strain and Young's modulus	14
7	Heat	15
TOTAL		**100%**

MODULES

Module: 1 Kinematics

General aim:
On completion of this module, the students should be familiar with solving analytical problems relating to practical situations where two objects move horizontally at constant velocity in different directions. Students must also be able to determine the resultant, velocity, shortest distance, time intersections, overtaking and actual velocity.

LEARNING CONTENT	**LEARNING OUTCOMES** **Students must be able to:**
1.1 Relative velocity	• Solve problems dealing with constant linear motion analytically (Pythagoras or Sine and Cosine rules) • Determine the relative velocity, shortest distance, time to intercept and actual velocity.
1.2 Resulting velocity	• Calculate resulting velocity and direction of a maximum of two vectors. • Calculate time to reach a certain destination.
1.3 Projectiles	• Do calculations dealing with projectiles that are launched horizontally from a certain vertical height or launched at an angle from the horizontal landing on the same horizontal plane • Calculate maximum height reached by an object as well as time of flight and range. • Calculate height and velocity at any part of the projectile path. • Calculate velocity of projection. • Calculate the angle of projection

DIDATIC GUIDELINE:
A maximum of TWO simultaneous motions will be examined.

Module 2: Angular Motion

General aim:
On completion of this module, the student should be able to calculate angular displacement, velocity and acceleration. Students should also be able to calculate torque required for acceleration as well as work done and power.

LEARNING CONTENT	**LEARNING OUTCOMES** **Students must be able to:**
2.1 Angular Displacement	• Calculate angular displacement.
2.2 Angular Velocity	• Calculate angular velocity.
2.3 Angular Acceleration	• Calculate angular acceleration • Calculate linear acceleration and distance moved by an object.
2.4 Relationship between	• To understand the relationship between linear

linear and angular quantities.	and angular quantities
2.5 Torque Work done and Power	• Calculate accelerating and decelerating torque if the mass moment of inertia of an object is given • Calculate Work done • Calculate power

Module 3: Dynamics

General aim:
3.1 On completion of this module, the student should be able to understand to state and apply three Newton's laws of motion.

LEARNING CONTENT	**LEARNING <u>OUTCOMES</u> Students must be able to:**
3.1 Newton's three laws of motion	• State Newton's three laws of motion. • Apply Newton's second law of motion. • Sketch free body diagrams of vehicles travelling on horizontal or inclined planes while moving at constant speed, accelerating or decelerating. • Calculate the tractive effort and braking effort required for motion on horizontal and inclined planes with regard to practical problems, including gravitational force, rolling resistance force and inertia force. • Calculate work done over a given distance or during a given time. • Calculate power at a given instant or at a given velocity.
3.2 Kinetic and Potential energy	• Calculate Kinetic and Potential energies and energy loss • Define the concept of kinetic and Potential energy
3.3 Conservation of energy	• Apply the conservation of energy equation for vehicles travelling due its own weight only on horizontal and inclined planes (no tractive effort or braking effort applied)

Module 4: Statics (Loading of Beams and Centroids)

General aim:
On completion of this module, students should be able to calculate reactions at each support. Students should be able to calculate point of inflection.

LEARNING CONTENT	**LEARNING <u>OUTCOMES</u>** **Students must be able to:**
4.1 Simply supported beams and Cantilevers with point loads and Uniformly distributed loads.	• Calculate reactions at each support • Draw shear force diagram. • Calculate and draw Bending moment diagram. • Calculate point of inflection (**Moved from N5**) • ~~Draw loaded beam from given Shear-force diagram~~
4.2 Centroids of laminae	• Calculate centroids of different shapes e.g. rectangles, tri-angles, circles and semi-circles including compound shapes made up from these mentioned shapes.
4.3 Centre of gravity of solid shapes	• Calculate the centre of gravity of different shapes e.g. cylinders, cones, spheres and semi-spheres including compound shapes made up from these mentioned shapes.

Module 5: Hydraulics (Hydraulic presses, hydraulic pumps and Hydraulic Accumulators)

General aim:
On completion of this module, the student should be able to analytically solve practical problems which deal with the determination of volume, pressure, diameter as well as work done by the press.

LEARNING CONTENT	**LEARNING <u>OUTCOMES</u>** **Students must be able to:**
5.1 Hydraulic Presses	• Calculate the volume of liquid required per stroke by the press. (slip to be taken into account) • Calculate the diameter of the ram of the process or force exerted by the ram. • Calculate pressure in the liquid to overcome a given load • Calculate the work done by the press (efficiency to be taken into account)
5.2 Hydraulic Pumps	• Calculate the volume of liquid delivered per stroke for a reciprocating pump(slip to be taken into account) • Calculate the theoretical and actual flow rate of a reciprocating pump • Calculate the pressure in the liquid and force on the plunger. • Calculate rotational frequency of a pump to deliver a given flow rate of water. • Calculate the time taken to fill or empty a reservoir for a given flow rate

	• Calculate power required and efficiency with input power given in the case of single, double and three cylinder single acting pumps.
5.3 Hydraulic Accumulators	• Name the types of accumulators found in industry • State the functions of an accumulator in a hydraulic system • Determine the volume of liquid delivered by the accumulator per working stroke of the machine it serves or the volume delivered in a given time. • Calculate the diameter of the ram and the load required on the accumulator to keep the pressure required constant during the working stroke. • Calculate the distance travelled by the accumulator ram during the working stroke. • Calculate the transfer of pressure in the liquid between the accumulator and the machine. • Calculate the work done and power with efficiency. (slip to be taken into account) • Draw sketches, which illustrate the working of an accumulator.

Didactic Guide

The liquid is regarded as static when the pressure is calculated, i.e. no efficiency factor is taken into account. In calculations on volume however the slip is taken into account and efficiency is taken into account when calculating work done and power.

Module 6: Stress, Strain and Young's Modulus

General aim:

On completion of this module, the student should be able to do calculations on tensile and compressive test, including the determination of cross sectional areas to satisfy the given condition.

LEARNING CONTENT	**LEARNING <u>OUTCOMES</u> Students must be able to:**
6.1 Stress types	• Name the three main types of stresses. (Direct, shear and bending) • Calculate direct stresses including determination of cross-sectional areas or maximum load on a member if stress limit is known. Compound bars should be included.(The nature of the stresses should be mentioned) • Calculate shear stress including determination of shear areas as well as maximum load on a member if stress limit is known. • Calculations on single and double shear should be included.

	• Calculations on Stress, Strain and Young's Modulus for the material.
6.2 Young's modulus	• Calculate stress and strain • State Hooke's law and define Young's modulus of elasticity. • Draw stress and strain graph or force-distance graph. (limited to elastic limit) with clear reference to the direct proportionality between stress and strain. • Calculate change in length or total change in length for compound rods

Module 7: Heat **Added new sections**

General aim:

On completion of this module, the student should be able to analytically solve practical problems which deal with the volumetric expansion and contraction of solids, liquids and gasses. (The student should also be aware of the anomaly in the expansion of water) When dealing with gasses the students should be able to sketch and do calculations on simple gas processes.

LEARNING CONTENT	**LEARNING <u>OUTCOMES</u> Students must be able to:**
7.1 Volumetric change in solids	• Calculate the volumetric coefficient of expansion given the linear coefficient of expansion • Calculate the change in volume and final volume due to temperature change • Calculate the percentage change in volume
7.2 Volumetric change in liquids	• Explain the anomaly in the expansion of water • Calculate the change in volume and final volume • Calculate the change in the level of the liquid in a container due to temperature change • Calculate overflow in a container filled with liquid due to temperature change
7.3 Volumetric change in gasses	• State the characteristic gas law with relevant formula • State Boyle's law with relevant formula and PV-graph • State Charles's law with relevant formula and VT-graph • State Gay Lussac's law with relevant formula and PT graph • Do calculations on pressure, volume, temperature, mass and gas constant on all four different processes
7.4 Gas processes	• Define the three basic gas processes (isochoric, isobaric and isothermal) • Sketch the PV diagrams for isochoric, isobaric and isothermal processes. • Do calculations on work done, change in internal energy and heat flow for all three processes. • Sketch PV diagrams of a maximum of two successive gas processes • Do calculations on work done, change in internal energy and heat flow for the two successive processes.